PRINCIPLES OF MANUFACTURING

COURSE DESCRIPTION

Principles of Manufacturing focuses on the essential principles that must be mastered for a person to be effective in manufacturing production work. The course is intended for students more interested in production than engineering. The course covers customers, quality principles and processes, systems, information in the workplace, the business of manufacturing, and statistical process control.

The course is contextual by design. It connects what is being learned to the learner's current experience, past knowledge, and future conduct. Wherever possible, real-world or simulation hands-on experiences become the context in which instruction is delivered.

It is strongly recommended that administration and guidance follow the scope and sequence and course recommendations as listed.

Recommended Credits: 1

Recommended Grade Level(s): 9th or 10th

Number of Competencies in Course: 41

PRINCIPLES OF MANUFACTURING

STANDARDS

1.0 Students will perform safety examinations and maintain safety records.

2.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

3.0 Students will integrate reading, writing, math, and science skills and understand the impact of academic achievement in the workplace.

4.0 Students will analyze the components of a manufacturing system.

5.0 Students will adapt processes to meet customer needs using quality principles.

6.0 Students will access, evaluate, record, organize, and evaluate information typical of a manufacturing workplace.

7.0 Students will analyze and differentiate the fundamental organizational components of manufacturing organizations.

8.0 Students will analyze the fundamental economic components and functions of manufacturing organizations.

9.0 Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.

PRINCIPLES OF MANUFACTURING

STANDARD 1.0

Students will perform safety examinations and maintain safety records.

LEARNING EXPECTATIONS

The student will:

1.1 Demonstrate a positive attitude regarding safety practices and issues.
1.2 Use and inspect personal protective equipment.
1.3 Inspect, maintain, and employ safe operating procedures with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
1.4 Demonstrate continuous awareness of potential hazards to self and others and respond appropriately.
1.5 Assume responsibilities under HazCom (Hazard Communication) regulations.
1.6 Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies to protect coworkers and bystanders from hazards.
1.7 Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
1.8 Demonstrate appropriate related safety procedures.
1.9 Pass with 100 % accuracy a written examination relating to safety issues
1.10 Pass with 100% accuracy a performance examination relating to safety.
1.11 Maintain a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

1.1A Is attentive during safety discussions.
1.1B Actively seeks information about safe procedures.
1.1C Responds positively to instruction, advice, and correction regarding safety issues.
1.1D Does not deliberately create or increase hazards, such as by horseplay, practical jokes, or creating distractions.
1.1E Reports to school or work physically ready to perform to professional standards, such as rested, or not impaired by medications, drugs, alcohol, etc.
1.2 Selects, inspects, and uses the correct personal protective equipment for the assigned task.
1.3A Inspects power tools for intact guards, shields, insulation, and other protective devices.
1.3B Inspects extension cords for the presence of a functional ground connection, prior to use.
1.3C Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or company policy.
1.3D Properly places and secures ladders and scaffolding prior to use.
1.4A Is observant of personnel and activities in the vicinity of the work area.
1.4B Warns nearby personnel, prior to starting potentially hazardous actions.
1.5A When asked to use a new hazardous material, retrieves MSDSs (material safety data sheets), and identifies the health hazards associated with the new material.

1.5B Reports hazards found on the job site to the supervisor.
1.6A Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous tasks.
1.6B Provides and activates adequate ventilation equipment as required by the task.
1.7A Reports all injuries to self to the immediate supervisor.
1.7B Reports observed unguarded hazards to their immediate supervisor.
1.8 Complies with personal assignments regarding emergency assignments.
1.9 Passes with 100% accuracy a written examination relating specifically to content area.
1.10 Passes with 100% accuracy a performance examination relating specifically to welding tools, equipment and supplies.
1.11 Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Conduct a practice drill simulating a hazardous solvent spill in which an emergency action plan is to be implemented.
- Instruct a visitor to obviously approach the vicinity of a student conducting a hazardous activity and note the level of awareness demonstrated by the student.
- For a project requiring the use of ladders and/or scaffolding, note the proper placement and securing procedures followed by students.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Ford Academy of Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. English/Communications/Writing/Reading/Problem-Solving/Teamwork skills and content.

PRINCIPLES OF MANUFACTURING

STANDARD 2.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

2.1 Cultivate positive leadership skills.
2.2 Participate in the student organization directly related to their program of study as an integral part of classroom instruction.
2.3 Assess situations, apply problem-solving techniques, and decision-making skills within the school, community, and workplace.
2.4 Participate as a team member in a learning environment.
2.5 Respect the opinions, customs, and individual differences of others.
2.6 Build personal career development by identifying career interests, strengths, and opportunities.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

2.1A Demonstrates character and leadership using creative-and critical-thinking skills.
2.1B Uses creative thought process by "thinking outside the box."
2.2A Relates the creed, purposes, motto, and emblem of their student organization, directly related to personal and professional development.
2.2B Plans and conducts meetings and other business according to accepted rules of parliamentary procedure.
2.3A Makes decisions and assumes responsibilities.
2.3B Analyzes a situation and uses the Professional Development Program or career technical student organization materials directly related to the student's program of study to resolve it.
2.3C Understands the importance of learning new information for both current and future problem solving and decision making.
2.4A Organizes committees and participates in functions.
2.4B Cooperates with peers to select and organize a community service project.
2.5A Researches different customs and individual differences of others.
2.5B Interacts respectfully with individuals of different cultures, gender, and backgrounds.
2.5C Resolves conflicts and differences to maintain a smooth workflow and classroom environment.
2.6A Creates personal career development by identifying career interests, strengths, and opportunities.
2.6B Identifies opportunities for career development and certification requirements.
2.6C Plans personal educational paths based on available courses and current career goals.
2.6D Creates a resume that reflects student's skills, abilities, and interests.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various career technical student organizations' programs and/or competitive events.
- Implement an annual program of work.
- Prepare a meeting agenda for a specific career technical student organization monthly meeting.
- Attend a professional organization meeting.
- Develop a program of study within their career opportunities.
- Participate in the American Spirit Award competition with SkillsUSA.
- Complete *Professional Development Program Level I and Level II*, SkillsUSA.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 3.0

Students will integrate reading, writing, math, and science skills and understand the impact of academic achievement in the work place.

LEARNING EXPECTATIONS

The student will:

3.1 Assume responsibility for accomplishing classroom assignments and workplace goals within accepted time frames.
3.2 Develop advanced study skills.
3.3 Demonstrate and use written and verbal communication skills so others can understand.
3.4 Read and understand technical documents such as regulations, manuals, reports, forms, graphs, charts, and tables.
3.5 Apply the foundations of mathematical principles such as algebra, geometry, and advanced math to solve problems.
3.6 Apply basic scientific principles and methods to solve problems and complete tasks.
3.7 Understand computer operations and related applications to input, store, retrieve, and output information as it relates to the course.
3.8 Research, recognize, and understand the interactions of the environment and green issues as they relate to the course work and to a global economy.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

3.1A Uses appropriate time management to achieve goals.
3.1B Arrives at school on time each day.
3.1C Completes assignments and meets deadlines.
3.2A Assesses current personal study skills.
3.2B Demonstrates advanced note-taking ability.
3.2C Formulates appropriate study strategies for given tasks.
3.3A Communicates ideas, information, and messages in a logical manner.
3.3B Fills out forms, time sheets, reports, logs, and documents to comply with class and project requirements.
3.4A Reads and understands technical documents and uses industry jargon, acronyms, and terminology related to machining and manufacturing appropriately.
3.4B Recognizes the meaning of specialized words or phrases unique to the career of the machining and manufacturing industry.
3.5A Utilizes computation in adding, subtracting, multiplying, and dividing of whole numbers, fractions, decimals, and percents.
3.5B Chooses the right mathematical method or formula to solve a problem.
3.5C Performs math operations accurately to complete classroom and lab tasks.
3.6A Understands scientific principles critical to the course.
3.6B Applies scientific principles and technology to solve problems and complete tasks.
3.6C Has knowledge of the scientific method (e.g., identifies the problem, collects information, forms opinions, and draws conclusions).

3.7A Uses basic computer hardware (e.g., PCs, printers) and software to perform tasks as required for the course work.
3.7B Understands capabilities of computers and common computer terminology (e.g., program, operating system).
3.7C Applies the appropriate technical solution to complete tasks.
3.7D Inputs data and information accurately for the course requirements.
3.8A Researches and recognizes *green* trends in career area and industry.
3.8B Examines current environmentally friendly trends.
3.8C Applies sustainability practices by understanding processes that are non-polluting, conserving of energy and natural resources, and economically efficient.

SAMPLE PERFORMANCE TASKS

- Examine and compile different learning styles for portfolios.
- Create calendars containing all activities and obligations for one month. Discusses how to handle conflicting or competing obligations then complete daily and weekly plans showing tasks, priorities, and scheduling.
- Complete self-assessments of study habits.
- Compute precise and exact measurements.
- Explore study strategies for different subjects and tasks then analyze two homework assignments and select the best strategies for completing them.
- Create "life maps" showing necessary steps or "landmarks" along the path to personal, financial, educational, and career goals.
- Take notes during counselor classroom visits and work in small groups to create flow charts of the path options.
- List attitudes that lead to success then rate individually in these areas. Work together to suggest strategies for overcoming the weaknesses identified own and partners' self-assessments then share with the class the strategies developed.
- Research the Internet and other technology to collect and analyze data concerning climate change.
- Keep a data file of alternative energy sources and the sources' impact on the environment.
- Develop a recycling project at home or for the school environment.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 4.0

Students will analyze the components of manufacturing systems.

LEARNING EXPECTATIONS

The student will:
4.1 Analyze the systems common to manufacturing organizations.
4.2 Evaluate the role of customers in the manufacturing process.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
4.1A Diagrams an end-to-end manufacturing workflow that brings revenue to an organization and the dependencies in the system.
4.1B Categorizes a manufacturing system as customized, batch, or continuous.
4.1C Distinguishes between natural, synthetic, and mixed materials.
4.1D Correlates the interchangeability of parts with increased effectiveness in manufacturing processes.
4.1E Illustrates the interrelationships between a worker and the worker's team.
4.2A Analyzes the meaning and function of a "customer."
4.2B Compares and contrasts internal and external customers and their relationships to the manufacturing process.
4.2C Assesses customer needs and correlates them to the manufacturing process.
4.2D Differentiates between durable and non-durable goods.

SAMPLE PERFORMANCE TASKS

- Students apply concepts in the context of a manufacturing simulation in which a product moves through the various work processes.
- Students conduct customer and supplier interviews.
- Students will create a flowchart of a system process.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 5.0

Students will adapt processes to meet customer needs using quality principles.

LEARNING EXPECTATIONS

The student will:
5.1 Assess the effects of quality assurance on manufacturing processes.
5.2 Analyze the relationship between process management and quality assurance.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
5.1A Infers the relationship between quality and customers.
5.1B Diagrams a quality process.
5.1C Illustrates key principles and concepts of quality assurance.
5.1D Concludes the benefits of implementing quality assurance.
5.1E Correlates quality with the critical success factors of an organization.
5.2A Incorporates principles of process management.
5.2B Assesses advantages of process management.
5.2C Validates the need for feedback loops within a system.
5.2D Devises modifications to a manufacturing process.

SAMPLE PERFORMANCE TASKS

- Students apply concepts in the context of a manufacturing simulation in which a product moves through the various work processes.
- Students conduct customer and supplier interviews.
- Students use quality-improvement tools such as Plan-Do-Check-Act or seven-step problem-solving model.
- Students flowchart a system process.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 6.0

Students will access, evaluate, record, organize and evaluate information typical of a manufacturing workplace.

LEARNING EXPECTATIONS

The student will:
6.1 Access and process data commonly used in manufacturing.
6.2 Evaluate and interpret data relevant to manufacturing processes.
6.3 Record data relevant to manufacturing processes.
6.4 Organize data relevant to manufacturing processes.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
6.1A Locates and collects reliable and relevant data from pertinent sources.
6.1B Processes data according to requirements of a given manufacturing situation.
6.2A Reports any deviation from expected results.
6.2B Makes modifications based on facts to improve the process.
6.2C Selects an appropriate set of criteria for evaluating data.
6.2D Evaluates information according to a set of criteria.
6.3A Judges the relevance of data to a given process.
6.3B Maintains accurate logs of information.
6.4A Incorporates statistical processes to analyze data.
6.4B Interprets findings using process-control data.
6.4C Uses diagrams and drawings to convey information.

SAMPLE PERFORMANCE TASKS

- Students use information effectively in the context of a simulation in which a product is "manufactured."
- Anticipatory activity—Conduct a scavenger hunt for information.
- Students make measurements.
- Students flowchart a process.
- Students role-play benefits of information sharing.
- Students forecast information.
- Students record information on spreadsheets.
- Students sort and graph data electronically.
- Students critique presentations.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 7.0

Students will analyze and differentiate the fundamental organizational components of manufacturing organizations.

LEARNING EXPECTATIONS

The student will:

7.1 Analyze and differentiate organizational designs and structures.
7.2 Analyze and differentiate organizational systems and processes.
7.3 Investigate and assess the role of personal accountability within an organization.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

7.1A Distinguishes various organizational designs and assesses the impact of each on people and work.
7.1B Differentiates between formal and informal organizations and illustrates their relationships to one another.
7.2A Categorizes the various bases of power and leadership.
7.2B Demonstrate the dynamic relationship among organizational units.
7.2C Illustrates the communication system used in organizational designs.
7.2D Predicts the impact of quality initiatives on the success of an organization.
7.2E Demonstrates the importance of feedback loops.
7.3A Assesses the impact of an individual's behavior on an organizational system.
7.3B Demonstrates personal accountability.

SAMPLE PERFORMANCE TASKS

- Students identify the parts of an organization, such as the school.
- Students identify the climate and culture of the organization.
- Students identify their personality traits and types.
- Students identify management styles of leaders known to the students.
- Students complete circle activity to demonstrate being a component in a system.
- Students play a board game that demonstrates how change in one part of an organization impacts other parts of the organization.
- Students participate in relay game to highlight personal accountability.
- Students draw reinforcing feedback loops to highlight individual accountability.

INTEGRATION/LINKAGES

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PRINCIPLES OF MANUFACTURING

STANDARD 8.0

Students will analyze the fundamental economic components and functions of manufacturing organizations.

LEARNING EXPECTATIONS

The student will:

8.1 Analyze the basic economic principles that impact manufacturing operations.
8.2 Draw conclusions and make inferences from company financial statements.
8.3 Compare and contrast the costs of preventive maintenance and safety practices with the costs of equipment repair and workplace accidents.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

8.1A Investigates the need for profitability of a manufacturing business.
8.1B Determines factors that lead to profit and loss.
8.1C Draw conclusions whether or not a product feature is value-added.
8.1D Categorizes marketing activity as product identity, research, distribution, or sales.
8.2A Interprets data contained in a financial report.
8.2B Assesses factors that affect variability of costs and steps in the manufacturing process that impact cost.
8.2C Calculates the cost of employee benefits and analyzes the role of organized labor in determining salary and benefits.
8.3A Compare and contrast the costs of accident prevention with the costs of accidents.
8.3B Compare and contrast the cost of servicing to keep in good repair versus replacing or repairing.

SAMPLE PERFORMANCE TASKS

- Students analyze company financial statements.
- Students participate in manufacturing scenarios/simulations that require them to make decisions and then examine the economic consequences of those decisions.

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Manufacturing Sciences (FAMS curriculum). Project Lead the Way curriculum. Mathematics content.

PRINCIPLES OF MANUFACTURING

STANDARD 9.0

Students will implement quality and statistical process control procedures to ensure and improve quality in manufacturing processes.

LEARNING EXPECTATIONS

The student will:

9.1 Analyze the contributing factors to an industrial process.

9.2 Apply statistical process control concepts to evaluate and modify manufacturing processes.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:

9.1A Predicts the effect of workplace documentation on specific work.

9.1B Determines the problem in a manufacturing process.

9.1C Resolves the problem by applying appropriate problem-solving techniques.

9.2A Performs basic mathematical calculations, calibrations, and measurements.

9.2B Conducts an in-process inspection and uses the information to adjust a process.

9.2C Performs a Pareto Chart analysis.

9.2D Identifies the source of any large disparity using the following tools and concepts:

- control charts
- histograms and specifications
- variability and predictability
- shape of a distribution, measures of center, measures of spread
- interpreting a curve and plotting the X-bar and R control chart
- special cause variation

SAMPLE PERFORMANCE TASKS

- Students determine an acceptable range of ripeness for fruit they might purchase.
- Students complete a Pareto Chart.
- Students construct a histogram.
- Students construct a fishbone diagram.
- Students participate in a Law of Large Numbers activity.
- Students calculate center and spread.
- Students plot a control chart.
- Students interpret a control chart.

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